

SHRIMP MARICULTURE AT THE BUREAU OF COMMERCIAL
FISHERIES BIOLOGICAL LABORATORY

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Since 1950, shrimp consumption in the United States has increased from 118.3 million pounds (heads-off weight) to 336.8 million pounds. This represents a 6% annual increase. Shrimp consumption increased from 0.8 pounds to 1.7 pounds per person in that period, a 115% gain. In comparison, during 1950-68, per-capita consumption of meat, poultry, and fish combined increased 19%.

In 1950, shrimp imports were only 40% of the domestic landings; since 1961, imports have been greater than total domestic landings (Table 1 and Fig. 1). According to Cleary (1970), two important observations can be made:

1. Each 1% gain in per-capita real income tends to be accompanied by a 1.8% increase in per-capita shrimp consumption.
2. Each 1% increase (relative to general price level) in the retail price of shrimp is accompanied by a 0.5% decline in per-capita consumption.

With these data, we can predict with some reliability what demand and consumption are likely to be in the future. Present world production is slightly more than 1 billion pounds. U. S. consumption of shrimp in 1968 was 337 million pounds, or about one-third of the world production. If production increases as anticipated, the total world catch will reach 1.9 billion pounds by the late 1970's.

There has been considerable speculation concerning the development of a shrimp farming industry in this country. Although the technology for shrimp farming has not been developed, we do anticipate commercial activity in some phases of shrimp culture in the near future. The first profitable commercial operations will probably be the culture of shrimp for the live bait markets. The relatively high price paid for live bait will permit

Table 1. U.S. catch and imports of shrimp by years ^{1/}

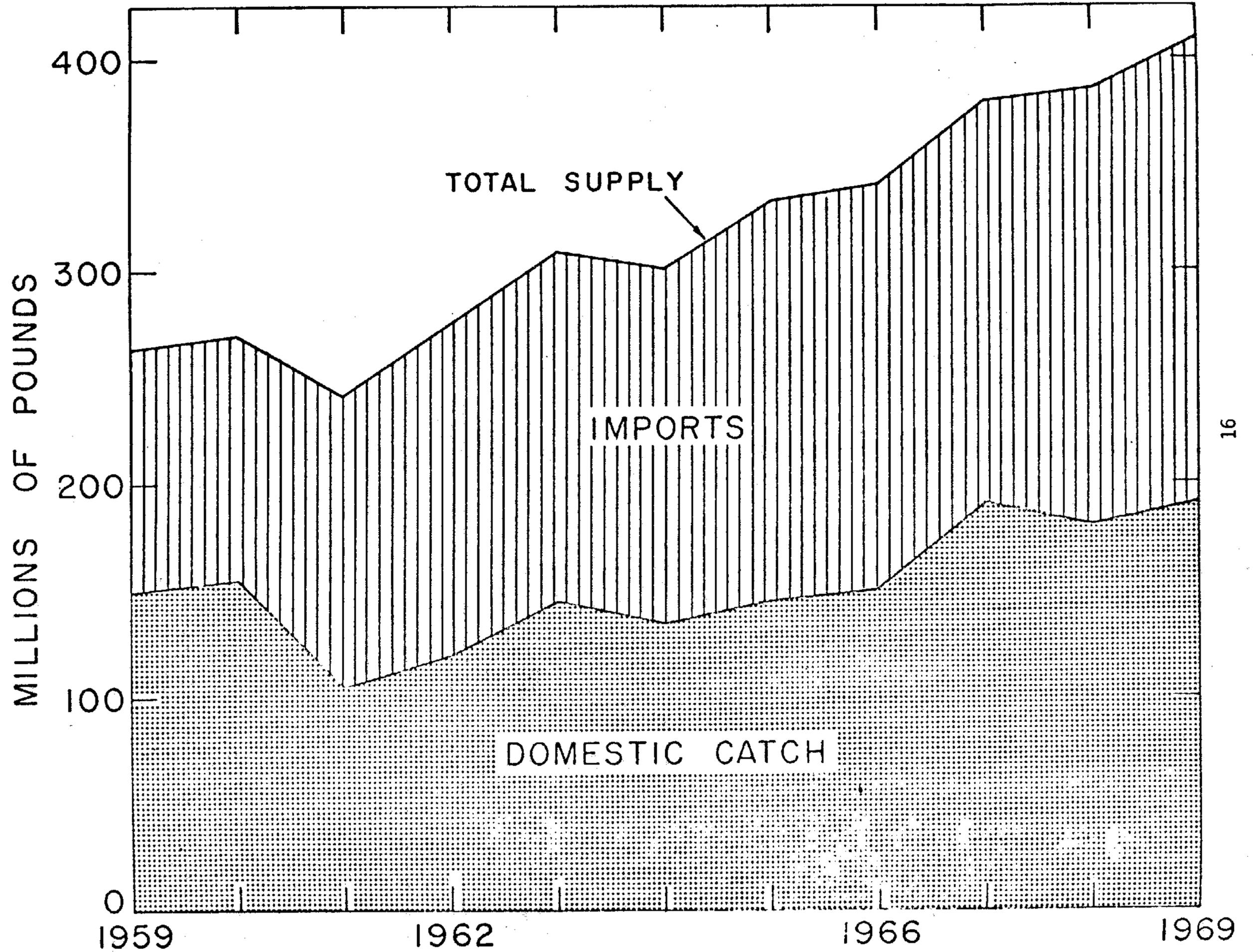
Year	U. S. catch			Imports ^{2/}			Total Heads-off
	Heads-on	Heads-off	Percent of total	Import Weight	Heads-off	Percent of total	
	<u>Thousand pounds</u>	<u>Thousand pounds</u>	<u>Percent</u>	<u>Thousand pounds</u>	<u>Thousand pounds</u>	<u>Percent</u>	<u>Thousand pounds</u>
1959	240,182	142,965	56	106,555	111,704	44	254,669
1960	249,452	148,483	55	113,418	119,139	45	267,622
1961	174,530	103,865	44	126,268	134,564	56	238,429
1962	191,105	119,154	44	141,183	152,504	56	271,658
1963	240,478	150,737	47	151,530	167,344	53	318,081
1964	211,821	133,113	44	154,577	169,510	56	302,623
1965	243,645	152,346	46	162,942	178,955	54	331,301
1966	239,046	148,255	43	178,549	194,946	57	343,201
1967	307,787	189,972	48	186,073	202,105	52	392,077
1968	291,600	179,430	46	189,455	209,342	54	388,772
1969	*317,100	195,500	47	*193,741	220,100	53	*415,600

^{1/} From Fisheries of the U.S. 1969, U. S. Department of the Interior, CFS No. 5300, 50 pp.

^{2/} Imports for 1959-69 were converted to heads-off weight on the basis of available data on the actual condition of the imports. *Record.

Figure 1. U. S. catch and imports of shrimp by years. (From Fisheries of the U. S. 1969, U. S. Department of the Interior, CFS No. 5300, 50 pp.).

(HEADS-OFF WEIGHT)



profitable production of small shrimp in ponds despite the fact that efficient culture techniques are not available. Under normal weather conditions, two crops per acre could be harvested annually. However, if heated effluent from a power plant was used, six crops could be harvested. Commercial production of postlarval shrimp will develop hand-in-hand with the bait shrimp operations.

Table 2 lists the poundage and value of food and bait shrimp harvested from 1966 to 1969 from the Galveston Bay system. This is only a portion of the total Texas catch. Of particular interest is the relative size of catches made by the bait shrimp industry. Although the supply of live bait varies from year to year, the average price paid per quart is \$2.75; dead bait brings only 50¢ a pound. Generally speaking, the bay-caught shrimp are the size that can now be reared economically in ponds.

The second commercial application of shrimp-rearing know-how, which will be possible from the technical standpoint, is that of stocking. Stocking of artificially reared shrimp in natural waters may be desirable in areas where natural production is always poor or at times when natural reproduction is poor because of environmental fluctuations. We do not know whether stocking will be economically beneficial. A careful evaluation of costs and benefits is needed before decisions can be made in this area.

The third type of commercial development will probably be farming of shrimp in ponds for sale as food. Several problems have prevented the development of shrimp farming for the food market. These are (1) the high cost of obtaining young shrimp for stocking, (2) the fact that no efficient foods are available, and (3) the low price per pound paid for shrimp of the small sizes which can be raised in ponds.

Research objectives at the Bureau of Commercial Fisheries Biological Laboratory in Galveston, Texas, are planned to aid commercial development on a long-term basis. These include the refinement of hatchery techniques so that operating costs will be reduced and the survival of larval shrimp will be increased. Additionally we hope to determine the nutrition requirements of shrimp and to formulate suitable artificial foods for shrimp of all sizes. Considerable effort will be directed toward maturation of shrimp in captivity. When methods are developed for holding shrimp through their entire-life cycle, selective breeding will begin, and true farming will be possible.

Shrimp culture work at the Galveston Biological Laboratory consists of collecting live female shrimp in spawning condition, spawning them in the laboratory, hatching the eggs, and rearing the larvae. Female shrimp are collected in the Gulf of Mexico and are held at low temperature until their arrival at the laboratory. In the laboratory the gravid females are acclimatized to warmer water temperatures. Spawning usually occurs within 48 hours if the shrimp are in a ripe condition. Shrimp are spawned in 5-gallon carboys, and the eggs are transferred to 250-gallon tanks.

Table 2. Galveston Bay shrimp landings

Year	<u>1/</u> Bait shrimp catch		<u>2/</u> Food shrimp catch		Combined value
	Weight	Value	Weight	Value	
	<u>Pounds</u>	<u>Dollars</u>	<u>Pounds</u>	<u>Dollars</u>	<u>Dollars</u>
1966	785,900	872,900	3,677,300	2,803,400	3,676,300
1967	1,087,900	1,271,800	6,200,600	3,581,600	4,853,400
1968	1,102,600	1,336,800	4,740,100	3,767,100	5,103,900
1969	1,007,500	1,259,375	5,629,500	4,579,000	5,838,375

1/ K. N. Baxter, personal communication, Bureau of Commercial Fisheries, Biological Laboratory, Galveston, Texas.

2/ J. W. Morgan, personal communication, Bureau of Commercial Fisheries, Biological Laboratory, Galveston, Texas.

The eggs hatch in about 12 hours, provided conditions in the water such as temperature, salinity, and pH are maintained within a narrow range suitable for the species. Conditions within the rearing tanks also are critical for the larvae which are reared to an age of about two weeks. The larvae are fed diatoms cultured in the laboratory during the early stages and brine shrimp (Artemia sp.) nauplii during the later stages.

By the age of two weeks, shrimp have reached the post-larval stage and can be transferred to brackish water ponds where they will grow to a length of about four inches utilizing natural foods. Rapid growth can be encouraged by adding fertilizers or feed to the ponds. In our ponds, growth diminishes as the shrimp approach the sizes at which they normally leave the estuaries and move offshore (3½ to 4½ inches). Although some male shrimp will mature sexually in the ponds, none of the females will.

As the demand for shrimp increases, not only in the United States but all over the world, shortages of natural stocks will focus more attention to mariculture. In 1968, Lindner and Cook (in press) indicated that shrimp culture had not reached the stage where they would recommend commercial hatcheries because of the lack of technology. Just 2 years later, a number of private companies have built hatcheries for the express purpose of growing and selling young shrimp for stocking.

Shrimp research at the Galveston Laboratory will continue to help solve the problems encountered in this commercial venture. Table 3, although speculative, illustrates what we think can now be done in ponds.

Table 3. Theoretical yields from 1-acre shrimp ponds
based on an assumed mortality of 50%

Stocking Rate	20,000 postlarval shrimp/acre	
Stocking Cost	\$7.50/1,000 postlarval shrimp \$150.00/acre	
Growing Period	65-80 days	100-125 days
Mortality	50%	50%
Harvest	10,000 shrimp/acre or 100 lb./80-100 count	10,000 shrimp/acre or 250 lb./31-40 count
Live Bait		
(1½lb./qt.)	66 qt.	166 qt.
(\$2.75/qt.)	\$181.50	\$456.50

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